Constellation-X Facility Science Team Meeting - 030507/08

Constellation

The Constellation X-ray Mission

Reflection Grating Spectrometer (RGS) Technology Status

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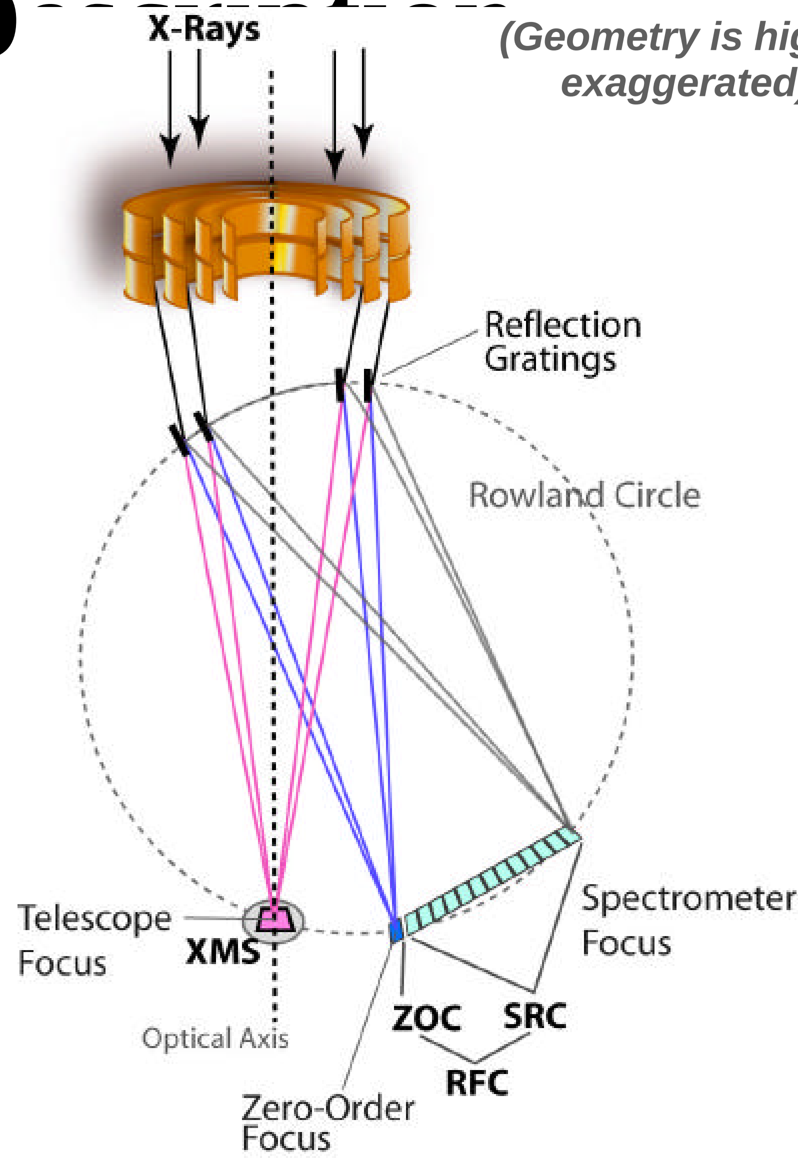
Gratings: (Optics, Subassembly Modules & RGA) - MIT Space Nanostructures Lab (M. Schattenburg)

CCDs: (Event Driven CCDs & RFC) - MIT Center for Space Research (G. Ricker)

Alternate design concepts: (e.g., off-plane grating geometry) - Univ. Colorado (W. Cash)

Reflection Grating Spectrometer (RGS) System Description

- Grating spectrometer is required to provide high spectral resolution at low energies.
- Bandpass of RGS is 0.25 – 2.0 keV.
- Gratings populate only the outerhalf of SXTexit aperture. Non-intercepted light goes to XMS at telescope focus.
- Zero order camera (ZOC) tracks small aspect drifts and corrects wavelength scale for events in spectroscopy readout camera (SRC).
- High efficiency gratings and large QE CCDs are key to RGS throughput.
- Design is compact — no additional length required behind the focus.

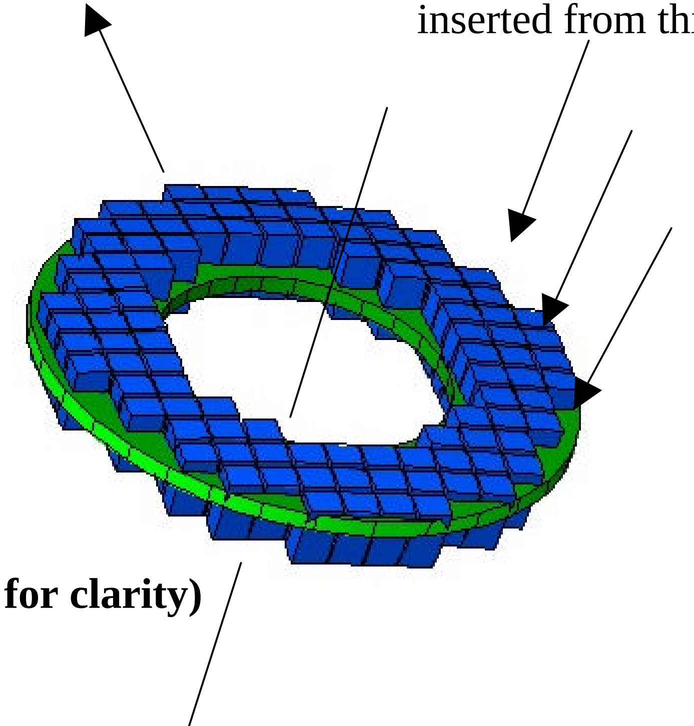


(Geometry is highly exaggerated)

RGA buildup from grating subassembly modules

Autocollimate grating faces from this side.

Grating modules are wedge shaped and can be inserted from this side.

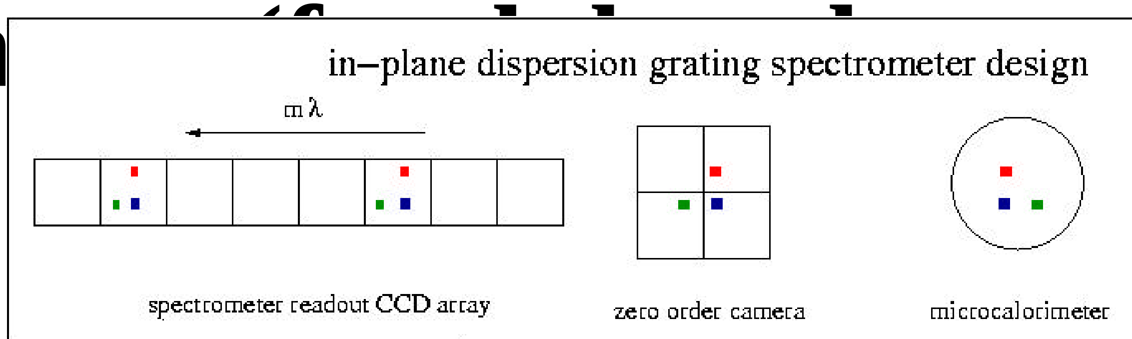


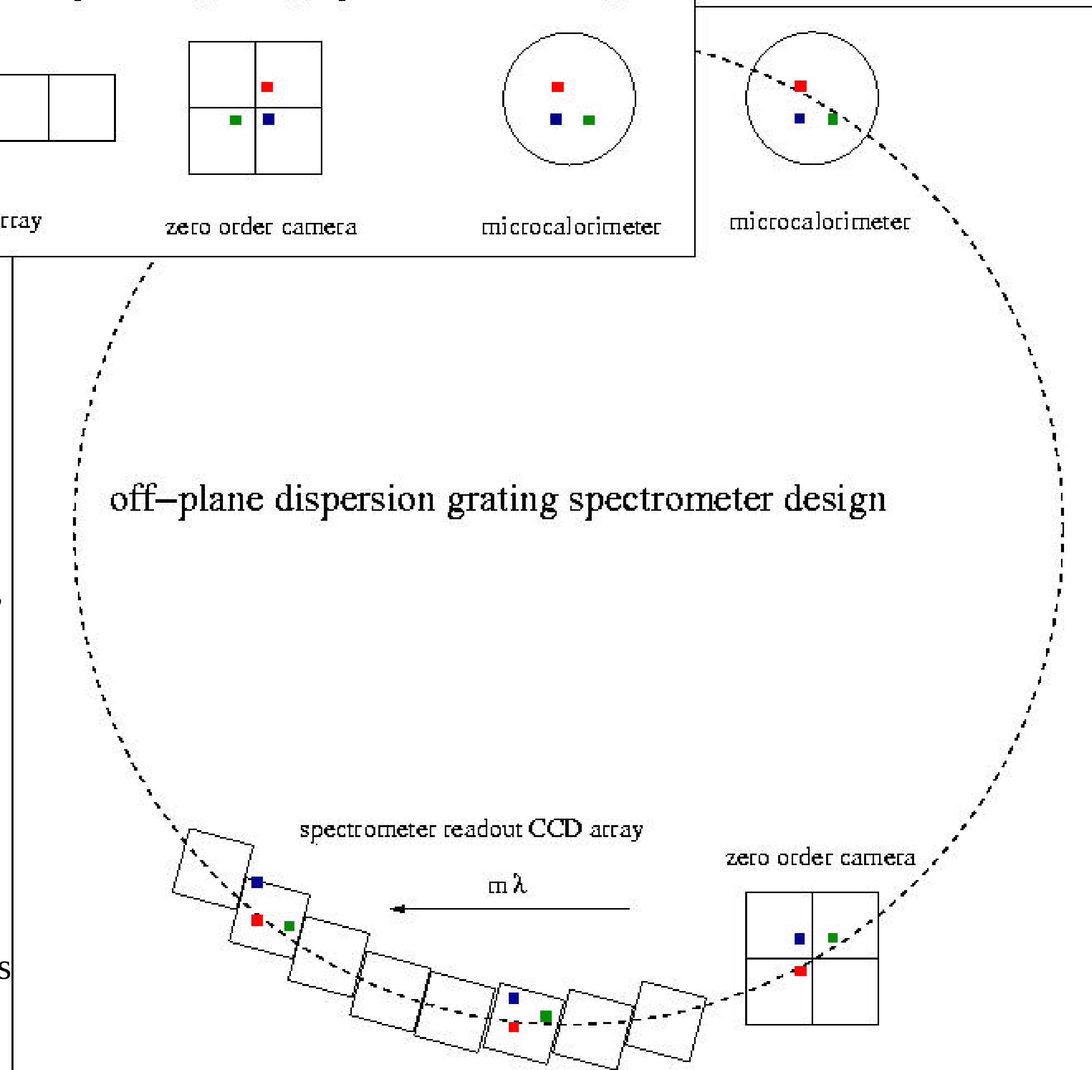
Relaxed alignment tolerances:
Because of converging beam geometry, grating misalignments and positioning misalignments are ***coupled***. Grating misalignments can be minimized even with fairly loose positioning tolerances. With L=9265mm, ? a = 2 arcsec corresponds to ? x = 0.09 mm.

(Assembly fixture and alignment system not shown for clarity)

SXT & RGS common optical axis

In-plane vs. Off-plane grating array geom





- Local resolving power is a function of "readout coordinate only" -- how many mapped PSFs can be fit into the effective dispersion angle.
- In-plane geometry suffers from internal vignetting (up to 30%) but dispersion angle can be extended.
- Off-plane geometry is "not vignetted" internally, but the dispersion angle range is limited.
- Flatness/alignment requirements are relaxed for off-plane geometry.
- R(in-plane) ~ R(off-plane), based on this cartoon.
- Primary benefit of off-plane geometry is high grating efficiency (TBD) so ~30% fewer gratings and higher packing density.
- Improvements in R can be achieved by ***SUBAPERTURING*** which is available in either design – *at a cost* of course..

Dispersion geometry downselect procedure

- Originally slated for 09/03, this early mostly for budgetary constraints and the need to focus resources in the technology development phase. A reassessment for readiness is required.
- Full efficiency curves for either grating geometry are required to make fair comparisons.
- A minimum performance/fabrication data must be available, vis a vis approaches that can produce flight parts with the required specifications. e.g., direct fabrication vs. replication and scatter performance degradation with each replication step. This may be solved already with MIT direct fabrication approach.
- The IPT will review the available performance data and consider arraying geometry models to raytrace and analyze 2D LSF predictions, including end-to-end throughput.
- Sample Constellation-X science observations should be simulatable via RMFs and background files.
- The IPT will recommend an RGS spectrometer design to an independent review panel, which will facilitate the downselect.

- MIT/CSR (EDCCD) status: George Ricker
- MIT/SNL (Substrates & Gratings) status: Ralf Heilmann
- Colorado (Off-plane measurements) status: Randy McEntaffer